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TIMOTHY PRODUCTION
ON IRRIGATED LAND IN THE
NORTHWESTERN
STATES.

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U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF PLANT INDUSTRY,
OFFICE OF THE CHIEF,
Washington, D. C., April 16, 1912.

SIR: I have the honor to transmit herewith a paper entitled "Timothy Production on Irrigated Land in the Northwestern States," by Mr. M. W. Evans, Scientific Assistant, of the Office of Forage-Crop Investigations of this Bureau.

The production of timothy hay is an important industry in many of the irrigated valleys of the Northwestern States. Some of the methods which have been developed in growing the timothy-hay crop in one or more of these valleys are not practiced or known in other important timothy-producing areas. One of the most important of these practices, which has but a limited use, is that of growing alfalfa in place of clover in mixture with the timothy. This practice is at present used in only a few of the most important timothy-producing centers, though it is well adapted to conditions on most of the irrigated land where timothy is produced. In view of these facts it is desirable to disseminate this information among the timothy growers of the Northwest.

Respectfully,

B. T. GALLOWAY,
Chief of Bureau.

HON. JAMES WILSON,
Secretary of Agriculture.

CONTENTS.

	Page.
Introduction.....	7
Conditions under which timothy thrives.....	8
Timothy in mixture with clover or alfalfa.....	8
Timothy in mixture with clover.....	9
Kinds of clover sown.....	9
Proportion of clover in the hay.....	10
Clover reseeding itself.....	10
Timothy in mixture with alfalfa.....	11
Proportion of alfalfa in the mixed hay.....	11
Timothy and alfalfa compared with timothy and clover.....	13
Feeding value of timothy mixed with clover or alfalfa.....	13
Seeding timothy.....	15
Time of seeding.....	15
The use of nurse crops.....	15
Method of seeding.....	16
Rate of seeding.....	16
Irrigation of timothy.....	17
Methods in use.....	17
Flooding from field ditches.....	17
Irrigation by the furrow method.....	18
Advantages and disadvantages of the flooding and furrow systems.....	18
Time of irrigation.....	19
Quantity of water used.....	19
Cultivation of established meadows.....	20
Fertilizers.....	20
Pasturing the meadows.....	21
General practice.....	21
Extent to which meadows may be pastured.....	21
Rotation of timothy with other crops.....	22
Crops grown in rotation with timothy.....	22
Reasons for using a rotation.....	22
Weeds in timothy fields.....	23
How weeds injure meadows.....	23
Important injurious weeds.....	24
Harvesting.....	25
Time of harvesting.....	25
Methods of harvesting.....	26
Baling the hay.....	28
Baling from the field or stack.....	28
Yield.....	29
Marketing.....	30
Different classes of markets.....	30
Methods of marketing.....	30
Grades of hay.....	30
System of grading in use.....	30
Percentage of clover or alfalfa in the hay.....	31
Summary.....	31

TIMOTHY PRODUCTION ON IRRIGATED LAND IN THE NORTHWESTERN STATES.

INTRODUCTION.

- Large quantities of timothy hay are produced annually on irrigated land in the Pacific Coast and Rocky Mountain States of the Northwest. The most important irrigated timothy-producing areas are located in western Montana, central Washington, central and eastern Oregon, southern Idaho, and in the northern part of Utah. Much hay is also grown in the Northwest, particularly in western Washington and western Oregon and in northern Idaho, on land where the rainfall supplies sufficient moisture for the growth of the crop or in mountain valleys where the soil is naturally subirrigated by water seeping down from higher levels.

The following statistics, given in Table I and published by the Bureau of the Census of the Department of Commerce and Labor in preliminary bulletins of the 1910 census, show the number of acres and tons harvested in 1909 both of timothy alone and of timothy mixed with clover in six of the Northwestern States. Figures obtained from the 1900 census report indicate that considerably more than half of the area in these States on which timothy is produced was then irrigated.

TABLE I.—*Statistics showing the acreage and quantity of timothy and timothy mixed with clover harvested in 1909 in six Northwestern States.*

State.	Timothy alone.			Timothy and clover mixed.		
	Total acreage.	Total yield.	Average yield per acre.	Total acreage.	Total yield.	Average yield per acre.
	<i>Acres.</i>	<i>Tons.</i>	<i>Tons.</i>	<i>Acres.</i>	<i>Tons.</i>	<i>Tons.</i>
Idaho.....	102,610	140,134	1.36	53,992	99,864	1.85
Montana.....	117,888	171,030	1.45	90,541	156,039	1.72
Oregon.....	40,166	67,239	1.67	66,652	129,278	1.93
Utah.....	16,819	34,214	2.03	11,508	24,115	2.09
Washington.....	88,298	143,461	1.62	120,890	253,194	2.09
Wyoming.....	29,433	44,655	1.51	8,066	16,328	2.02
Total.....	395,214	600,733	1.52	351,649	678,818	1.93

Assuming that the figures given in Table I are correct, it is interesting to note that the addition of clover in the timothy meadows pronouncedly increased the yields, except in Utah. Furthermore,

the yield per acre of timothy alone in Utah is considerably higher than in the other States. The comparatively high yield of timothy in Utah is probably due largely to the fact that practically all of the timothy hay produced in that State is grown on irrigated land, while in the other States a considerable proportion is produced on nonirrigated land.

CONDITIONS UNDER WHICH TIMOTHY THRIVES.

Timothy thrives best in the northern portion of the United States or at high elevations farther south, where the climate is comparatively cool during most of the growing season. In most of the areas where timothy is grown alfalfa does not produce more than three and sometimes not more than two crops during a season.

An ample supply of moisture in the soil is essential for the best growth of timothy. The roots of timothy plants do not penetrate as deeply into the soil as the roots of alfalfa or clover and consequently require a more constant supply of water near the surface. The best crops of timothy are obtained when the plants do not suffer for water at any time during the growing season.

In the valleys where timothy hay is produced the adaptation of this grass to certain types of soil is generally recognized. It should be grown on the clay or silt loams, which are retentive of moisture, while the coarser gravelly or sandy loams are better suited to the production of alfalfa, sugar beets, and grain.

Throughout the greater part of the section of the country under discussion the weather conditions at the time of hay harvest are ordinarily favorable for curing the hay. At this time of the year there are usually continuous sunshine and a dry atmosphere during the day, with but a light dewfall during the night and usually but little danger of rainfall. This condition makes it possible to harvest hay which retains its bright-green color and sells remarkably well.

TIMOTHY IN MIXTURE WITH CLOVER OR ALFALFA.

In the irrigated valleys of the West timothy is almost always sown in mixture with either clover or alfalfa, clover being more extensively used than alfalfa. In a few irrigated valleys, however, timothy and alfalfa have been grown together nearly as long as the land has been farmed. In the Kittitas Valley, Wash., where the land was formerly seeded with timothy and clover, alfalfa is being extensively used in place of clover in the meadows.

There are several important reasons for growing clover or alfalfa in combination with timothy. Timothy alone does not ordinarily produce more than one crop in a season; the second crop seldom makes enough growth to be worth harvesting for hay. Either red

clover or alfalfa, when grown with timothy, if the plants are numerous enough in the field, will produce a fairly good yield at the second cutting on land that is irrigated throughout the growing season. The total yield of hay from a meadow of timothy and clover, or timothy and alfalfa, in one season is considerably greater than from a meadow where timothy alone is grown.

A second important reason why clover or alfalfa is grown with timothy is the beneficial effect which either of these legumes has upon the soil. Experience has shown that when timothy is grown on the land continuously for a considerable number of years even the most fertile irrigated soils eventually begin to produce smaller yields than when the land was new. On the other hand, when clover or alfalfa is grown with the timothy these crops help to maintain the productivity of the soil.

A mixture of timothy and clover or alfalfa makes a more valuable feed for farm stock than timothy alone.

TIMOTHY IN MIXTURE WITH CLOVER.

KINDS OF CLOVER SOWN.

Medium red clover is well adapted to most soils where timothy is grown. It produces a less coarse and therefore a better quality of hay than the Mammoth red clover. Medium red clover will produce two crops each season, while Mammoth red clover will not ordinarily produce more than one cutting, though the yield from a single cutting of the latter variety is usually larger than the first cutting of Medium red clover. Of these two varieties, Medium red clover is better for growing in mixture with timothy on irrigated land and is the variety which is generally sown.

Although alsike clover is not as generally grown as Medium red clover, yet in some localities it is used to a considerable extent either with timothy or in combination with timothy and red clover. When a mixture of timothy and red clover is harvested, a light rain or dew falling on the hay causes the clover to turn brown and thus injures the appearance and market value of the hay.

Alsike clover is not so readily injured in this way, nor does it appear so conspicuously in the mixtures as red clover. Chemical analyses indicate that red clover and alsike clover contain approximately equal quantities of nutritive material. Farmers and hay buyers in the Northwest who have had experience with alsike clover hay generally have found that the alsike clover in mixture with timothy makes as good hay as timothy and red clover. Alsike clover will frequently produce good yields of hay on land which is too wet for red clover to grow well. It is also more hardy and is less likely

to be killed by the freezing and heaving of the soil in winter than red clover. Where such unfavorable conditions exist, alsike clover is a better variety than Medium red clover. Alsike clover, however, does not produce more than one crop each season and does not produce as large a yield of hay per annum as Medium red clover.

Wherever it grows well, Medium red clover is generally better than alsike clover for sowing in mixture with timothy. A combination of red and alsike clover, obtained by sowing 1 or 2 pounds of alsike clover seed with from 4 to 6 pounds of red clover seed, makes a very satisfactory mixture with the timothy in the meadow.

PROPORTION OF CLOVER IN THE HAY.

When clover is sown in mixture with timothy it usually forms the greater proportion of the first crop of hay cut the year after the field has been seeded and nearly all of the second crop. Afterwards the timothy ordinarily predominates in the first crop harvested each season, while if there is any second crop harvested it is composed chiefly of clover. In some localities where timothy is grown on irrigated land, the clover continues to volunteer in the meadows for 5 or 10 years after seeding but is more abundant in some years than in others. In the Kittitas Valley, Wash., a large crop of clover is cut the year after the meadow is seeded and a fair second crop is usually harvested. The second year there is usually some clover in the first crop, and sometimes a light second crop of clover may be harvested. After that the hay is nearly all timothy and but one crop is harvested from the field each season.

CLOVER RESEEDING ITSELF.

Under favorable conditions red clover will maintain itself in the meadows to a greater or less extent by reseeding for a considerable number of years. Alsike clover reseeds itself even more readily than red clover. When it has once been grown in a field in a locality to which it is well adapted it may continue to grow as a volunteer crop in the meadows even if not sown when the field was seeded down.

The clover reseeds itself in various ways—scattered in manure, by irrigation water, etc. Heads of the clover which have not been cut by the mowing machine with the first crop of hay may mature seed. If the fields are pastured too closely in the fall soon after the second crop is removed from the land, the clover will not have time to mature its seed and less clover will grow in the fields in ensuing years.

TIMOTHY IN MIXTURE WITH ALFALFA.

A combination of timothy with alfalfa makes a very satisfactory mixture for irrigated meadows wherever the soil and climate are suitable for the growth of both of these crops. Although timothy and alfalfa are grown together in only a comparatively few valleys, the exceedingly satisfactory results which have been obtained in these localities indicate that this mixture could be profitably used on a large proportion of the irrigated land where timothy is produced.

In localities where timothy and alfalfa have never been grown together the opinion generally prevails that such a combination would not be practicable, for the reason that the first crop of alfalfa is ordinarily ready to cut for hay about two weeks or more before the timothy hay crop is harvested. It is generally believed by farmers who have not had experience in growing timothy and alfalfa together that either the mixture would have to be cut before the timothy is ready or else the alfalfa stems would become woody and the alfalfa leaves turn yellow and fall badly by the time the timothy has arrived at the proper stage for cutting.

By the time the timothy begins to bloom the alfalfa plants are already in full bloom. As it grows in a field in mixture with timothy, alfalfa does not lodge, as it sometimes does when it grows alone, nor does it produce such a dense mass of leaves at the base of the plants as in fields of clear alfalfa. For this reason the lower leaves on the plants do not turn yellow and drop as readily as they do in a field where a dense stand of alfalfa is growing alone. As the alfalfa in mixture with timothy is ordinarily harvested two weeks or so later than when the alfalfa is grown alone, the stems are somewhat more woody when cut for hay. However, as the alfalfa stems do not usually become as coarse in a field when there is a dense stand of timothy plants as when grown alone and as the alfalfa stems do not form a large proportion of the total weight of the hay, this objection is not a serious one. Furthermore, in localities where alfalfa hay is fed to horses it is the usual custom to let the hay stand longer before cutting than if it were to be fed to sheep or cattle. In places where timothy and alfalfa are grown together the hay composed of this mixture has been found to be very good feed for horses or for any other kind of live stock.

PROPORTION OF ALFALFA IN THE MIXED HAY.

The first year that hay is harvested from a mixed timothy and alfalfa field the first crop is usually composed chiefly of alfalfa, with some timothy; the second crop is nearly all alfalfa. In subsequent years the first crop harvested each season is half or more timothy,

with a varying proportion of alfalfa; a second crop, which is nearly all alfalfa, is also harvested.

In fields where timothy and alfalfa are growing together the relative proportion of timothy and alfalfa in the first crop varies. The proportion of timothy to alfalfa depends upon the soil and climate, sometimes upon the age of the field, and to some extent upon the proportion of timothy and alfalfa seed sown.

In most of the irrigated valleys where timothy is grown the spring weather is cool; the soil is usually cool and moist, being kept in this condition either by the spring rains or by irrigation. Such cool atmospheric and soil conditions in early spring provide ideal conditions for the rapid growth of timothy. Whatever the relative number of timothy and alfalfa plants growing in the field may be, the timothy generally makes a more rapid growth than the alfalfa and therefore constitutes a larger proportion of the first crop of hay harvested after the first season.

The proportion of alfalfa in the first crop of hay may be increased or diminished to some extent by using a comparatively large or small amount of water to irrigate the fields while the crop is growing. When the first hay crop has been harvested both atmosphere and soil are warmer than during early spring. Under these conditions alfalfa makes a rapid growth, while timothy grows slowly. Consequently, the second crop of hay harvested each season is composed chiefly of alfalfa, with but a small amount of timothy.

On soils not well adapted for alfalfa, particularly on clay soils which tend to be somewhat wet, the alfalfa may gradually disappear. On fields where the soil is well adapted for both timothy and alfalfa and where the alfalfa is not injured by overirrigation, winterkilling, or other cause, the field may continue to produce a mixed timothy and alfalfa hay in the first crop for a period of 10 or 15 years or more.

When about equal quantities of timothy and alfalfa seed are sown, the proportion of alfalfa in the first crop of hay harvested each year may vary from about 15 to 50 per cent. On the other hand, hay fields near each other and on the same kind of soil which have been seeded with different amounts of timothy and alfalfa together in widely different proportions may produce about the same grade of mixed hay. However, the proportion of alfalfa in the hay may be increased or diminished to some extent by sowing a very small quantity of timothy seed and a very large amount of alfalfa seed or by sowing a large quantity of timothy and a small amount of alfalfa seed.

TIMOTHY AND ALFALFA COMPARED WITH TIMOTHY AND CLOVER.

Alfalfa cures into a brighter hay than does red clover and its stems are finer. A mixture of 10 or 20 per cent of alfalfa is much less conspicuous in timothy hay than is an equal proportion of red clover. Timothy hay containing as much as 30 or 50 per cent of alfalfa appears to have a considerably smaller proportion of alfalfa. Alfalfa continues to form a considerable proportion of the first crop and to produce a fair second crop of hay each season for an indefinite number of years; whereas in most timothy fields clover tends to disappear after the first season.

On stiff clay soils that are poorly drained either red or alsike clover is likely to prove a more satisfactory crop than alfalfa. In mountain valleys situated at high elevations, where the growing season is comparatively short and where hard frosts occur late in the spring and early in the fall, clover may be found a more satisfactory crop than alfalfa to grow in mixture with timothy. On irrigated land where alfalfa will grow well, however, particularly where the fields are to be kept in meadow for several years, the practice of sowing timothy and alfalfa instead of timothy and clover is recommended.

FEEDING VALUE OF TIMOTHY MIXED WITH CLOVER OR ALFALFA.

It is generally conceded that a mixture of timothy and clover or of timothy and alfalfa has a higher feeding value than clear timothy hay for sheep, beef cattle, or dairy cows. There is some difference of opinion as to the relative feeding value of mixed hay and timothy hay as a forage for horses. Teamsters and liverymen in cities generally prefer to buy timothy hay, and hay buyers in most parts of the country pay a higher price for clear timothy than for timothy hay containing even a small proportion of clover or alfalfa. On the other hand, some liverymen and teamsters who have had experience in feeding the mixed hay prefer to feed it instead of the clear timothy. Large numbers of farmers feed their horses hay containing as much as one-fourth of clover or alfalfa, and many farmers feed hay containing one-half or more of clover or alfalfa.

Table II, taken from Farmers' Bulletin 170 of the United States Department of Agriculture, gives the chemical composition of timothy, alfalfa, and red-clover hay. An examination of this table and of the succeeding one will give some idea of the relative feeding value of these three kinds of hay. The most important difference between timothy and clover or alfalfa as shown by these tables is the comparatively small amount of protein in the timothy.

TABLE II.—*Analyses of timothy, red clover, and alfalfa hay.*

Kind of hay.	Water.	Protein.	Fat.	Nitro- gen-free extract.	Fiber.	Ash.
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
Timothy.....	13.2	5.9	2.5	45.0	29.0	4.4
Red clover.....	15.3	12.3	3.3	38.1	24.8	6.2
Alfalfa.....	8.4	14.3	2.2	42.7	25.0	7.4

Table III, in part from the same source as the preceding one, gives the number of pounds of digestible nutrients in 100 pounds of timothy, red clover, and alfalfa hay.

TABLE III.—*Digestible matter in 100 pounds of timothy, red clover, and alfalfa hay.*

Kind of hay.	Protein.	Fat.	Nitro- gen-free extract.	Crude fiber.
	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>
Timothy.....	2.8	1.42	28.35	15.08
Red clover.....	6.85	.95	24.19	9.27
Alfalfa.....	10.67	.42	29.98	9.75

There are some objections to the use of clear clover or alfalfa hay for horses, particularly for horses at hard work or being driven constantly on the road. Either clover or alfalfa hay, when fed in too large quantities, has a laxative effect on the horses, while timothy when fed in too large quantities has the opposite effect. Clover and alfalfa contain a larger amount of protein in proportion to carbohydrates than is best for horses, while timothy is deficient in protein. Hay made of a combination of either a good quality of clover or alfalfa with timothy, in proper proportions, does not have any of these objectionable features.

In an investigation carried out at the Utah Agricultural Experiment Station, horses were fed for a period of several years on alfalfa hay and grain with good results. At the Illinois station horses fed on clover and grain gained more in weight than horses fed timothy and grain. Horses may be kept in good condition when proper proportions of either alfalfa or good clover hay are fed in combination with timothy and grain. The cost of the ration containing the mixed hay is less than the cost of a ration containing only timothy hay as less grain is required when the mixed hay is fed. Furthermore, alfalfa or clover hay, or hay composed of either in combination with timothy, usually sells for a smaller price than clear timothy hay.

SEEDING TIMOTHY.

TIME OF SEEDING.

It is the common practice in localities where timothy is grown under irrigation to sow the seed in the spring. Comparatively little timothy is sown in the fall. Some of the timothy growers wait until all danger of spring frosts is past. The seed is more often sown, however, early in the spring, soon after the soil has become in good condition to work. Experience has shown that when the seed is sown about April 1 the clover or alfalfa seedlings are seldom destroyed by frosts.

Spring rains in the mountain valleys usually keep the soil in a moist enough condition to germinate the seed which is sown early. These rains furnish sufficient moisture for the seedlings to produce considerable growth before irrigation is necessary. A good stand of grass can be more easily obtained under the climatic conditions of early spring than during the warmer, drier weather of the latter part of the spring, when it is necessary to depend upon irrigation to provide the moisture needed in the soil for germination and early growth.

THE USE OF NURSE CROPS.

In the Kittitas Valley of central Washington it is the general practice to sow the timothy with one of the spring grains as a nurse crop; in the Boise Valley, Idaho, a nurse crop is not often sown; while in the Teton Basin, Idaho, both methods of seeding are practiced. It seems to be a somewhat more common practice to use a nurse crop than to sow the timothy alone.

When the timothy and clover or alfalfa are sown without a nurse crop, a light yield of hay, about 1 ton or more per acre, is ordinarily obtained from the land the first year. When the grass seed is sown alone the seedlings are not retarded in their growth by being shaded by the nurse crop, nor is there danger of having the seedlings destroyed in spots where the grain may lodge. On some soils the young timothy seedlings need irrigation more frequently than is required by the nurse crop, and under such conditions better results are obtained by seeding alone.

Oats, wheat, and barley are used as nurse crops. Wheat or barley does not produce such a rank growth of leaves as oats and therefore does not shade the grass seedlings as much. On the other hand, oats can be irrigated more than either of the other two grain crops; consequently, they are sometimes sown in preference to wheat or barley.

When timothy is sown with a nurse crop the grain should be seeded more lightly than if it were sown alone. About two-thirds,

or even a little less, of the usual amount of grain per acre is sufficient when the land is seeded to grass. The grain is sometimes cut for hay with a mowing machine before it is mature. As the nurse crop is removed from the land earlier when it is utilized for hay, the timothy seedlings have a better chance to develop than when the nurse crop is allowed to mature. Furthermore, by cutting the nurse crop with a mowing machine for hay there is no tall stubble left on the field to be gathered up with the first hay crop.

The question of whether a nurse crop should be used in any particular locality and what grain crop is best suited for that purpose will have to be determined largely by the results of local experience. When a good stand of grass can be obtained with a nurse crop, a larger income is usually derived from the land than when no grain is sown. If, however, there is difficulty in obtaining a good stand of plants in the meadow where a nurse crop is used, then timothy and clover or alfalfa seed should be sown alone.

METHOD OF SEEDING.

Timothy seed alone or in mixture with alfalfa or clover is sometimes sown by hand, but more often with some kind of a hand seeder or with the grass-seeder attachment to the grain drill. When the attachment to the drill is used the seed should generally fall ahead of the disks or hoes of the drill, so as to be lightly covered by the drill. If the soil is in an ideal condition so that the grain will germinate readily if sown with the drill set at a shallow depth, the grass and alfalfa or clover seed may be conducted through the tubes so that it will fall under the hoes or disks with the grain. Care must be taken, however, especially on soils which tend to become baked or crusted on the surface, that the seed is not covered too deeply when sown in this way.

If the seed has been sown with a hand seeder it should be covered by harrowing with a spike-tooth harrow. If the seed is sown with the attachment to the grain drill and falls ahead of the disks or hoes, the soil may also be harrowed afterwards to cover the seed more uniformly.

The timothy and clover or alfalfa seed should be covered somewhat more deeply on light sandy soils than on clay soils. It also needs to be covered more deeply when the weather and soil are dry than when moist. The seed should be covered to a depth of about one-half inch to $1\frac{1}{2}$ inches, depending upon the soil conditions.

RATE OF SEEDING.

The total amount of seed and the proportion of each kind of seed sown vary widely in different locations and also on different farms in the same locality.

When timothy and clover are grown together the average quantity of seed sown is from 12 to 13 pounds per acre, about half of which by weight is timothy and half clover. The total amount sown by different farmers, however, varies from about 9 to 15 pounds of seed per acre. The proportions sown vary from 2 or 3 pounds of timothy and 10 of clover to 9 or 10 pounds of timothy and 2 to 4 pounds of clover seed per acre. When timothy is grown in mixture with alfalfa the average quantity of seed sown is about 14 pounds per acre, of which about 6 or 7 pounds are timothy and 7 or 8 pounds are alfalfa seed. The total amount of seed sown varies, however, from 7 or 8 to 20 or 21 pounds per acre. The proportion of each varies from 3 parts by weight of timothy and 1 part alfalfa to 1 part timothy and 3 parts alfalfa.

The proper amount of seed per acre and the proper proportions of seed to sow vary somewhat in different localities and can best be determined by practical experience. From 12 to 14 pounds of seed per acre, about half of which is timothy and half alfalfa or clover, will be found a satisfactory rate of seeding under most conditions. When the seed is sown in equal proportions there will be a much larger number of timothy plants than of alfalfa or clover plants in the meadows, since there are five or six times as many seeds of timothy in 1 pound as there are in 1 pound of alfalfa or red clover seed.

IRRIGATION OF TIMOTHY.

METHODS IN USE.

The systems and methods used in irrigating timothy in the different places where it is grown are generally the same as those used in irrigating other crops¹ in the same locality. Most of the timothy grown on irrigated land is irrigated by one of the two methods described below, viz, flooding from field ditches or by furrow irrigation. There are various other methods of irrigating land, however, which are as well adapted for irrigating timothy as other field crops.

FLOODING FROM FIELD DITCHES.

Probably more irrigated land on which timothy is grown is irrigated by flooding from field ditches than in any other way. When this system is used, ditches are plowed from the lateral ditch to different parts of the field and are distributed in such a way as to carry the water along the slopes or ridges, from which it can be diverted to flow over the surface of the soil. These ditches are made with a plow, preferably one having a double moldboard.

The distance apart that the ditches should be and their location are determined chiefly by the character of the soil, the slope of the

¹ Full descriptions of methods of irrigation are given in Farmers' Bulletins 373, "Irrigation of Alfalfa"; 392, "Irrigation of Sugar Beets"; and 399, "Irrigation of Grain."

land, and the volume of water available for irrigating. According to Prof. Samuel Fortier the average distance apart that the lateral ditches are placed is about 80 feet; the distance may vary, however, from 30 or 40 feet to 200 feet or more.

When the water is to be turned on the land, it is diverted from the main ditch into the field ditches. Dams are placed at the proper places in these ditches, so as to cause the water to flow over the surface of the land adjoining the ditch. When the soil to be irrigated from this point has become sufficiently moist, the dam is removed and another is placed farther down the ditch, from which more land is watered. This method of procedure is followed until the whole field has been irrigated.

IRRIGATION BY THE FURROW METHOD.

Irrigation by the furrow method is used extensively in the Kittitas Valley, Wash., and in some other irrigated valleys where timothy is an important crop. When land is irrigated in this way, shallow furrows are made parallel to each other. They are so located that the water may be turned into them from the lateral ditches and will flow through them toward the lower side of the field. The essential difference between this method and the one that has just been described is that in irrigating from furrows the water does not flow over the surface of the land as in flooding from ditches, but sinks down from the furrows and at the same time spreads laterally beneath the surface of the soil until all the soil between the furrows has become moistened. The furrows are usually made about 2 to 4 feet, but sometimes farther apart. On soil having a close texture through which the water seeps slowly the furrows need to be closer together than on soils through which the water can pass more rapidly.

ADVANTAGES AND DISADVANTAGES OF THE FLOODING AND FURROW SYSTEMS.

The system of irrigating the land from field ditches is ordinarily more cheaply and easily established than the furrow system. When the flooding system is used, it is not ordinarily necessary to keep the water in the ditches as long as it is in the furrows when the land is irrigated by that method. On some soils having a very fine, close texture the water seeps through very slowly, making the method of irrigating from furrows impracticable.

Where none of these objections to this method exists, however, it has some advantages over the flooding system. On land which tends to become injured by the presence of alkali salts, some timothy growers believe that when the field is irrigated by flooding the salts are washed down into the soil and the accumulation of salts at the surface is less than when the furrow system is used. The reverse

seems to be true, however. Less water is generally used when the land is irrigated from furrows than when it is flooded. When the land is flooded, the surface of the soil becomes compacted, thus causing evaporation of moisture from the soil to take place more rapidly and therefore the accumulation of alkali salts at the surface of the soil is greater than on land irrigated from furrows.

TIME OF IRRIGATION.

The date at which timothy fields are first irrigated each spring varies greatly. Where there is considerable snowfall during the winter and where spring rains commonly occur, it may not be necessary to irrigate the land until late in May or some time in the early part of June. Irrigation should begin, however, before the timothy suffers for lack of moisture in the soil.

The date at which the last irrigation is given to the land in the fall also depends upon the climatic conditions. It is the general practice in most places to irrigate the fields at least once and occasionally twice after the last crop of hay has been harvested. As the yield of hay in any season depends to a considerable extent upon whether the plants are kept in a vigorous condition of growth during the preceding autumn, it is important that the soil be not allowed to become so dry during the autumn as to impair the vigor of the timothy plants.

There is no stated time at which the fields should be irrigated. The land should be irrigated whenever the condition of the soil or plants indicates that the supply of moisture is becoming deficient. The maximum yields of hay can not be produced if the growth of the plants is checked at any time by a lack of available moisture in the soil. Timothy hay will have a larger proportion of leaves and the leaves at the base of the plant will remain green longer if the soil has been irrigated properly than if it has been allowed to become too dry. Where clover or alfalfa is growing in mixtures with the timothy and a second crop of hay is to be harvested from the field, the land should be irrigated a short time before or immediately after harvesting the first crop in order that the new growth from which the crop is to develop may make a rapid and vigorous start.

QUANTITY OF WATER USED.

For its best growth and development timothy requires a soil having an ample supply of moisture. It is not advisable to grow it on irrigated lands where there is likely to be a deficiency in the water supply during the growing season. Because of its comparatively shallow root system, timothy is less able to withstand a period of drought than alfalfa. This fact is well illustrated in the Natchez Valley, Wash., where the land is watered by two separate irrigation systems, one of

which supplies the land irrigated by it with a larger amount of water per acre than is supplied by the other system. On the land irrigated by the first-mentioned system, timothy is one of the most important of the crops grown, whereas under the second system alfalfa is extensively grown for hay while there is practically no timothy grown.

Clay or silt loam soils, which retain moisture better than sandy or gravelly soils, require less water than do the latter soils. Some other crop than timothy should ordinarily be grown on the sandy or gravelly soils.

The actual amount of water used on an acre of timothy is dependent upon the climatic conditions, particularly upon the amount of rainfall, and upon the soil, as well as upon the skill of the man irrigating the land. In some localities one miner's inch of water to each acre of land is about the maximum quantity required for timothy, while in most localities a smaller supply of water is sufficient. When the water applied on a soil is in excess of the needs of the crop, not only is the superfluous water wasted, but also, on many soils, the excess of water tends to aid in causing an increase in the quantity of alkali salts which accumulate on the surface.

CULTIVATION OF ESTABLISHED MEADOWS.

A large number of the farmers producing timothy on irrigated land cultivate the meadows each year. This work should be done early in the spring and before the plants have made much growth. The tools which may be used are the disk, the spring-tooth harrow, and the spike-tooth harrow. The spike-tooth harrow is not very effective when used alone. It is more often used to drag over the meadow after the field has been disked.

As the meadows become older the surface of the soil becomes more or less compacted. Cultivation helps to correct this condition.

FERTILIZERS.

On most of the irrigated farms where timothy is produced there is not a very large supply of barnyard or stable manure available for applying on the timothy meadows or to the crops grown in rotation with timothy. Most of the timothy grown on irrigated land in the Northwest is produced without the aid of commercial fertilizers. Many farmers, however, do spread the limited amounts of manure that are at hand on the meadows. The growth of the timothy responds quickly to the application of fertilizers, even on the most fertile irrigated soil. The yields of hay, particularly from meadows which have begun to deteriorate, can be greatly increased by a top-dressing of stable or barnyard manure. The number of years that a meadow will produce profitable crops may also be increased in this way.

PASTURING THE MEADOWS.

GENERAL PRACTICE.

The irrigated valleys are frequently bordered by open-range country, on which cattle, horses, or bands of sheep graze. In the fall the feed on the range often becomes short, and the stock is brought into the valleys for feed. The irrigated meadows are frequently rented as pastures for the range stock after the second crop of hay has been cut. On some farms the meadows are used only to pasture such stock as may be kept on the farm; on a smaller number of the farms the meadows are not pastured at all.

When a meadow is rented for pasture the use of the field is disposed of in different ways. The stock may be pastured for a stated price by the day, week, or month. Often, however, the use of the meadow is rented for a certain rate per acre, or a price agreed upon is paid for the use of the entire field. The price paid for the use of meadows for fall pasture varies in different localities and according to the amount of feed that is to be had in the field. The revenue derived in this way varies from about \$1 to \$2 per acre.

When the meadows are rented for pasture, they are usually pastured by either sheep or cattle, most frequently by sheep. When a meadow is rented to a sheepman, he ordinarily does not put the sheep in the field immediately after the second crop has been harvested, but waits until some time in the fall when there will be more feed available. He then brings in a band of sheep, usually numbering from one to three thousand, and keeps them there until all the grass has been grazed down. Usually the sheep are in one field for from a few days to one or two weeks; then they are taken elsewhere for feed. After the sheep have been removed from the field, the timothy plants and the clover or alfalfa plants have a short time in which to develop some growth before winter.

A meadow composed of a mixture of timothy and alfalfa or clover will generally produce more pasturage than a meadow of timothy alone. A mixture of timothy and either clover or alfalfa makes a better pasture than either of these two legumes alone. The sheep or cattle are less likely to become bloated if there is a considerable mixture of grass growing in the field than if the clover or alfalfa is growing alone.

EXTENT TO WHICH MEADOWS MAY BE PASTURED.

The opinions of timothy growers differ in regard to the practice of using the meadows for pasture. Some farmers maintain that any feed obtained from the field in the form of fall pasture is at the expense of the following year's hay crop. Other farmers pasture a limited

number of live stock owned on the farm in the meadows, but do not allow the grass to be grazed closely. Weeds of various kinds are likely to gain a foothold in a meadow which has been pastured too closely. Pasturing any kind of stock too soon after the fields have been irrigated, when the soil is yet soft and the plants are easily injured by trampling, is particularly harmful. All stock should be kept off the fields in the spring. Most of the timothy meadows are pastured to a greater or less extent in the fall; if care is used to keep the stock off the field when the soil is wet and if the grass is not grazed too closely, the use of the meadows for pasture at this time does not seem to damage them to a very great extent.

ROTATION OF TIMOTHY WITH OTHER CROPS.

In most of the irrigated areas where timothy is the important crop no very definite system of crop rotation is used. Generally the timothy occupies the land as long as it produces satisfactory yields. When soil, climatic, and other conditions are favorable for timothy production the meadows may continue to produce large crops of hay for a period of 10 or 15 years or more. When the meadows have deteriorated to such an extent that the yields harvested become unprofitable, the fields should be plowed and some other crops grown for two years or more. Although some irrigated meadows produce profitable crops for a period of 10 or 12 years, on most irrigated land the fields should not be kept in meadows for more than 3 to 6 years.

CROPS GROWN IN ROTATION WITH TIMOTHY.

The crops which are ordinarily grown in rotation with timothy are wheat, oats, or barley, though some intertilled crop, such as potatoes or sugar beets, may also be used.

The number of years that timothy should occupy the land depends to some extent upon the relative profits to be derived from timothy or from other crops grown in rotation with it. When timothy is the most important crop it is generally reseeded on the field two or three years after the old meadow has been plowed up. When timothy is of less relative importance the land may be used for the production of other crops for an indefinite number of years after the meadows have been plowed.

REASONS FOR USING A ROTATION.

There are several advantages to be gained by growing timothy in a proper rotation with other crops. Experience has demonstrated that most soils will produce larger yields when different crops are grown in rotation than when a single crop is grown on the same soil for a long period of years. Those weeds which gradually gain a foothold in meadows as they become older can be eradicated from the

field most successfully by plowing up the land and using it for the production of annual, especially intertilled, crops for a few years. Even in an old meadow which is comparatively free from weeds, plowing up the old plants and reseeding to secure a stand of young plants may result in larger crops of hay.

Experience has shown that the practice of growing either clover or alfalfa in mixture with timothy results in increased yields of hay. These legumes also have a beneficial effect on the soil. The clover and alfalfa not only increase the nitrogen supply in the soil, but also utilize plant food that otherwise would not be available, as their roots penetrate to a greater depth into the soil than do those of timothy. When the roots of the clover or alfalfa plants decay, particularly those roots which have penetrated to the deeper layers of the soil, they add to the humus content of the soil and tend to make it more porous by the open spaces left where the roots were growing.

WEEDS IN TIMOTHY FIELDS.

When the irrigated lands of the West were first farmed, there were comparatively few bad weeds in the fields. After the land has been farmed for a number of years, however, weeds of various kinds begin to appear. These weeds are usually introduced through the seed, which is sometimes present in the seed of grain, grasses, clover, or alfalfa. Some of these weeds are unimportant, while others become serious pests. As a rule the annual weeds, such as wild oats, mustard, and sunflowers, which are troublesome in grain fields, are not bad weeds in permanent meadows. Nearly all of the plants which become troublesome weeds in timothy fields are perennials, though there are some exceptions to this rule, as in the case of squirreltail grass, which is a winter annual.

HOW WEEDS INJURE MEADOWS.

Weeds are injurious in the timothy fields for two reasons: The yields of hay harvested are usually reduced and the quality of the hay grown is more or less injured. Some of the plants which come into the meadows, such as dock or squirreltail, have no feeding value when they are harvested and may therefore be classed as noxious weeds. There are some other plants, as bluegrass or redtop, which make good pasture, or hay if harvested at the proper time, but which, when growing in timothy fields, reduce the quantity and quality of hay harvested and therefore become weeds in the meadows.

There are other weeds, besides those described later, which may be abundant in a few localities or which may be quite generally distributed, but which are not numerous enough or injurious enough to become of much importance.

IMPORTANT INJURIOUS WEEDS.

Squirreltail grass or western foxtail (*Hordeum jubatum* L.) is one of the most widely distributed and also one of the worst weeds found on irrigated land. It is a winter annual, like wheat or rye. The seeds produced in the summer germinate and grow during the fall and the plants produce seed and die the following season. In meadows where there is a good stand of timothy plants over the entire field, this weed does not establish itself in sufficient numbers to become very injurious. In spots where the timothy and clover or alfalfa plants have disappeared and left a thin stand, particularly in alkali spots, the squirreltail quickly occupies the ground. Not only is it worthless for feeding to stock, but, as it is very conspicuous in the hay, a small quantity in a field injures the appearance and selling value of the hay. When it is present in only a few spots in the field the squirreltail may be mowed and burned before the timothy is ready to harvest. When a field has become badly infested, it should be plowed and devoted to grain or some other crop for two or three years.

Curled dock (*Rumex crispus* L.) is one of the most common of the perennial weeds which grow in the meadows on irrigated land. It produces medium-coarse stems and foliage and grows to a height of about 3 feet. Usually the plants grow singly, scattered over the field. Because of their coarse texture and brown color they are quite conspicuous in the hay and injure its appearance and market value. The farmers often go through the fields before haying and either pull or cut out the plants and later burn them.

There are two or three other kinds of dock which grow in timothy meadows, but none is of as much importance as the species just described.

Dandelion (*Taraxacum taraxacum* (L.) Karst.) is a very common weed in timothy meadows in many of the irrigated valleys. It is most conspicuous in the spring when the plants are in flower. Later in the spring the dandelions are hidden from view as the timothy plants become larger. The dandelions do not injure the quality of the hay, as the old flowering stalks have dried and withered up by the time that the hay is cut. It is somewhat uncertain whether the presence of dandelions in the field ordinarily reduces the hay yield much, though when they have once become established in a locality it is practically impossible to eradicate them from the meadows. Dandelions are less numerous, as a rule, in new meadows than in old ones.

Kentucky bluegrass (*Poa pratensis* L.) and Canada bluegrass (*Poa compressa* L.) grow in the meadows in many timothy-producing areas in the West. The bluegrasses are usually introduced into new farming localities with seed sown in lawns, pastures, etc. The bluegrass

gradually encroaches upon the meadows, and in five or six years it may become so plentiful as to cause considerable reduction in the yield of hay.

As the bluegrass matures earlier than the timothy and has become a light-straw color by the time that the hay is cut, it also injures the appearance and quality of the hay when present in sufficient quantity. The bluegrass gradually forms a dense, tough sod in which the timothy and clover or alfalfa do not make as large or vigorous growth as where there is no bluegrass. The bluegrass grows most rapidly where the stand of plants in the meadow is comparatively thin. Too much irrigation, overpasturing, or other bad practices in the management of the meadows tends to favor its development. In some of the timothy-producing areas bluegrass is regarded as the worst weed that grows in the meadows. When it has once gained a foothold in a meadow, it may be killed out by plowing the field and using it for the production of some annual crops for two or three years.

Redtop (*Agrostis alba* L.) is found in most localities where timothy is grown. Although it makes a fairly good quality of hay if cut at the proper time, the presence of the redtop in the timothy decreases the value of the hay. Redtop is naturally adapted for growing in a comparatively moist soil and grows most commonly in low, wet spots in the meadows. It is also more common in old neglected meadows than in hayfields which have been more lately reseeded. Its presence may usually be taken to be an indication that the field needs to be plowed and reseeded and possibly drained.

HARVESTING.

TIME OF HARVESTING.

The date when timothy harvest begins varies with the season and with other conditions. In southern Idaho, in some of the valleys having a comparatively low elevation, timothy haying begins about July 1 or a few days earlier. In most of the localities where timothy is grown on irrigated land, however, timothy harvest commences anywhere from July 5 to July 15 and even at a later date in a few high mountain valleys. The date when timothy is cut depends also upon whether it is grown alone or with clover or alfalfa. When either of these two legumes is growing in mixture with the timothy, the hay is ordinarily harvested 10 days or more sooner than when the timothy is grown alone, the date at which it is cut depending to some extent upon the relative proportion of clover or alfalfa in the hay.

The period over which timothy harvest extends also varies widely. In some localities the haying season does not last for more than ten days or two weeks, while in other localities a period of about three

weeks may intervene between the date when the first and the last timothy is cut.

When clover or alfalfa is grown with the timothy, there is usually a second crop harvested. The date at which it is cut depends principally upon the date when the first crop was cut and also upon the weather conditions. The second crop is most usually cut about September 1, though it is frequently cut at an earlier or a later date.

When timothy is grown alone the best time to harvest the hay is when the heads are in full bloom or at any time within about a week after the plants have passed that stage. Timothy is rarely cut before the plants begin to bloom and as a rule must be cut within a few days after the plants have passed the blooming stage. The value of the timothy hay in the market depends to a great extent upon the condition in which it is harvested. If left to stand until the lower leaves begin to dry, not only are the quality and feeding value decreased, but the lighter green color of the hay, with the dry brown leaves mixed in, injures the appearance and quality of the hay to such an extent that its market value is considerably reduced.

The results of experimental investigations indicate that the largest yields are obtained when timothy is cut from about the time when the plants are passing out of bloom up to the time when the seed is in the dough stage. The timothy is more palatable and will yield the greatest amount of digestible food per acre if cut at the time of full bloom or even a little sooner. When it is grown in combination with clover or alfalfa it is necessary to cut the timothy soon after it has reached the stage of full bloom in order to harvest the clover or alfalfa in good condition.

When the timothy is in full bloom about one-third or one-half of the red clover heads will have turned brown, but the clover ordinarily is still in condition to make a good quality of hay. Alfalfa will usually be in full blossom several days earlier than timothy, and some of the lower leaves will fall from the plants by the time the timothy is ready to cut. If handled carefully in harvesting there is not much loss of leaves from the alfalfa and it, in combination with timothy, makes a most excellent quality of hay if cut when the timothy plants are in full bloom.

METHODS OF HARVESTING.

After the hay has been mown it is left to wilt in the swath before being raked into windrows. Soon after it has become wilted it should be raked up, as there will be a loss of leaves from the hay if it is allowed to become too dry in the swaths. The hay also cures with a better color if gathered into windrows or bunches. A dew or rain falling on the hay in the swath after it has become partially dried causes it to become badly discolored. The hay is ordinarily ready to place in the stack in from one to three days after it has been cut.

Throughout the West one of the most common methods of handling hay is to mow, rake, then to gather the windrows into loose bunches by means of horserakes, and to haul the hay on buck rakes to the stacks, which are located in convenient places in the fields. On many of the smaller farms and ranches hand forks are used to pile the hay from the windrows into cocks. This is a slower and more laborious method than to bunch the windrows with hayrakes.

When the hay is cocked, however, the cocks are more compact than the bunches made by the rakes; the hay cures in better condition, particularly if rains occur; and if the hay is to be handled with forks it can be pitched more easily from cocks than from loosely made bunches. The buck rake is extensively used to gather timothy hay, either directly from the windrows or from bunches which have been made with rakes, and to haul the hay to the stacks. The chief advantage to be derived from the use of the buck rake is that the hay can be handled more rapidly and more cheaply than by most other methods.

In many localities the hay is hauled from the fields to the stacks on wagons or sleds. More labor is required to handle the hay in this way than when the buck rake is used. On the other hand, when the hay is piled in cocks and is pitched with forks upon the hay rigging, less of the leaves are lost and less dust and rubbish is gathered with the hay than when a buck rake is used. A larger load of hay can be handled on a hay rigging than on a buck rake, which gives the wagon or sled some advantage over the buck rake when the stacks are located some distance from the field. Where the land is irrigated from field laterals or ditches, these ditches sometimes interfere to a greater or less extent with buck rakes.

Sleds for hauling the hay from field to stack are sometimes used in place of wagons. The sled for hauling hay consists of two low runners on which a flat rigging is made by nailing narrow boards on the crosspieces of the sled. The rigging is usually about 14 or 16 feet long and about 8 feet wide. The man who pitches the hay also arranges the load on the sled. About 800 or 1,000 pounds of hay can be hauled on a sled, but there is much less work required to pitch the hay upon a low sled than to pitch the hay onto an ordinary wagon. When sleds are used the hay is generally placed on rope slings, by means of which it is lifted up to the stack.

Most of the timothy hay grown in the irrigated valleys of the West is placed in stacks; comparatively little is stored in barns. The stacks are generally distributed through the fields where the hay is grown, though sometimes, particularly on the smaller farms, they are placed in permanent stack yards.

There are several kinds of stackers in use. When the hay is gathered with buck rakes, a stacker having long wooden teeth similar

to the teeth of the buck rake is used. The hay is pushed by the buck rake upon the teeth of the stacker and then is carried up and thrown on the stack. It is not possible to make the stack very high with a stacker of this type.

When the hay is hauled to the stack on a wagon or sled a derrick stacker is used. The hay is lifted from the hay rigging with a hay-fork or a hay sling and is carried by means of ropes and pulley up on the stack. With a stacker of this type, stacks 20 or 25 feet in height can easily be made.

On the larger farms or ranches hay harvest is sometimes carried on by what is termed a full crew of men, horses, and tools. A full crew consists usually of about 7 men and 11 or 12 horses. Two men and two teams mow the hay, one man and a team rake and bunch, two men and two teams operate the buck rakes, one boy or man with one horse or team operates the stacker, and one man arranges the hay on the stack. On most farms or ranches, however, a less number of men and horses do the work. Three or four men with five or six horses may do the haying by first mowing and raking and then using all men and teams to stack until more hay must be mowed. On the smaller farms, two or three men with two to four horses generally do the work.

BALING THE HAY.

When the timothy hay is sold and consumed in local markets it is often marketed without baling. Practically all of the hay that is shipped by railroad to markets which are more or less distant is baled.

The hay is usually baled by men who go from farm to farm with a baling machine and with a crew of men to do the work. The cost of baling is about \$2 a ton.

BALING FROM THE FIELD OR STACK.

Timothy hay is sometimes baled directly from the fields, when the baling machine is available at harvest time. In the Pacific and Rocky Mountain States, where the weather is generally clear and bright during the period when hay is harvested, a good quality of timothy hay may be produced for market by baling directly from the field, provided that care is taken to have the hay thoroughly dried before it is baled. There is more difficulty experienced in curing timothy containing a considerable mixture of clover or alfalfa dry enough to bale directly from the field, for the reason that if the clover or alfalfa is allowed to dry sufficiently so that it will not mold in the bales the hay may become so dry and brittle that there is likely to be considerable loss brought about by the breaking off and shattering of the leaves.

Most of the timothy hay which is produced for market on irrigated land is placed in stacks, where it remains for some time before it is

baled. It is usually easier to produce a high grade of hay in this way than by baling directly from the field. The hay is left in the stacks until it has passed through the sweating process, which takes about a month or more. If the hay is baled before the sweating process has been completed, it is likely to become somewhat discolored and may sometimes mold or become caked in the bales.

YIELD.

The yield obtained at the time of the first cutting either from fields of timothy growing alone or in mixture with clover or alfalfa ranges from about 1 to $3\frac{1}{2}$ tons or more per acre, though the more common yields are about $1\frac{1}{2}$ to 2 tons per acre. As is shown in Table I, page 7, the average yield of timothy grown alone in six of the Northwestern States in 1909 was 1.52 tons per acre, while the average yield of timothy grown in mixture with clover in these States was 1.93 tons per acre. Ordinarily only one crop is harvested from meadows where no clover or alfalfa is growing in mixture with the timothy.

When clover is sown with the timothy, a second crop of hay composed chiefly of clover will be harvested the first year and sometimes also the second year that the field is in meadow. The second crop of clover adds about 1 to $1\frac{1}{2}$ tons of hay per acre to the total yield.

When timothy is sown in mixture with alfalfa and the soil and climate are suitable for the production of both of these crops, two crops of hay are harvested each season for an indefinite number of years. The second crop harvested each year usually yields from about 1 to $1\frac{1}{2}$ tons per acre, and the total yield each year is increased by the same amount. In one valley where the mixture is grown alfalfa and timothy yield from 3 to $4\frac{1}{2}$ tons per acre from the two crops, of which $2\frac{1}{2}$ to 3 tons are harvested from the first crop of mixed timothy and alfalfa and 1 to $1\frac{1}{2}$ tons, chiefly alfalfa, are produced by the second crop. In another valley situated at a higher elevation and having a climate less well adapted for alfalfa and a soil less well adapted for timothy than that found in the first valley, the first crop of hay ordinarily yields about 2 tons per acre and the second crop of alfalfa about 1 ton per acre, making a total average yield of about 3 tons per acre.

As timothy meadows become older the tendency is for the yields of hay to decrease. The meadows are frequently left to stand for so long a time before plowing and reseeding that the crops of hay harvested are only one-half or less of what the soil should normally produce. In one valley where timothy production is the most important industry and where many of the fields had not been plowed for 10 years or more, the average yield of hay per acre was estimated to be about $1\frac{1}{2}$ tons per acre. In the same area there are numerous fields more recently reseeded with timothy and alfalfa which produce a total annual yield in two cuttings of from $3\frac{1}{2}$ to $4\frac{1}{2}$ tons of hay per acre.

MARKETING.

DIFFERENT CLASSES OF MARKETS.

The markets for timothy hay are in the towns and lumber or mining camps distributed through the West, at military forts or reservations, in the cities on the Pacific coast, and for feeding to range stock during the winter. During recent years a considerable quantity of hay has been shipped from the Pacific coast to Alaska, Hawaii, and the Philippine Islands. In most localities a large part of the crop is fed on the farm, but in some valleys the bulk of the crop is marketed.

METHODS OF MARKETING.

When the land on which it is grown is located near markets or where there are good facilities for transporting it, timothy hay is marketed quite extensively. In some hay-producing valleys located near enough to the Pacific coast so that freight rates are not too high, large quantities of both clear and mixed timothy hay are shipped to the coast every year. Where hay is grown at distances far enough from the coast to make the freight rates comparatively high, the amount of hay shipped to these markets varies with fluctuating conditions. In years when the price of hay is low or when there is an unusual demand for hay for feeding to range stock, but little hay may be sent to the more distant markets. When the price of hay is comparatively high, a considerable quantity of the best grade of hay may be shipped from places located several hundred miles inland to the cities on the coast.

When the hay is sold in local markets, the farmers usually sell directly to the liverymen, teamsters, or stockmen. When the hay is sent to a more distant market, however, it is usually purchased by some local dealer who is a representative of or agent for some large commission firm. The hay may be sold at any time during the autumn, winter, or spring, though most of it is baled and sold during the fall months. Though the price is often higher in the winter or spring, the hay can be removed from the stacks sooner and can be hauled when the roads are in a better condition when it is sold in the fall.

GRADES OF HAY.

SYSTEM OF GRADING IN USE.

There is a great deal of variation in the ways that timothy hay is graded for market in different localities and in different seasons. The system of grading hay as established by the National Hay Association is seldom strictly adhered to in the Western States when hay is bought and sold. In seasons when the supply of hay is small and the price is high, hay which in ordinary years would sell for No. 2 may sell for nearly or quite the same price as No. 1 hay.

Some markets are less exacting than others in the type of hay which they demand. Hay containing a considerable proportion of clover or alfalfa, when sold in local markets, often sells for as high a price as clear timothy. In the larger city markets clear timothy hay sells better than a mixed hay in which clover or other hay plants are present in large proportions.

Timothy hay is graded according to the condition in which it has been harvested and the proportion of the other plants which it contains. The most usual constituents besides timothy which are found in the hay produced on irrigated land are clover and alfalfa. Most other plants which may be harvested with the timothy are classed as weeds, and their presence in the hay decreases its value in proportion to their abundance.

PERCENTAGE OF CLOVER OR ALFALFA IN THE HAY.

The amount of clover which may be contained in hay classed as No. 1 timothy varies under different conditions. A small proportion of red clover appears conspicuously in hay which has been exposed to dew or rain and injures its salability more than if the hay has been harvested under favorable conditions. Red clover is coarser, turns to a dark color more readily during the process of harvesting, and appears more conspicuously in the hay than alsike clover. According to the rules of the National Hay Association, No. 1 timothy hay should be timothy mixed with not more than one-eighth clover or other tame grasses, properly cured, good color, sound, and well baled. The proportion of clover that may actually be present in hay that sells for No. 1 timothy, however, may be less or may be considerably more than one-eighth, depending on the conditions which have been mentioned.

In one of the most important hay-producing regions of the Northwest a large proportion of the timothy hay sold contains alfalfa, which is usually present in proportions varying from about 20 to 50 per cent. Since the alfalfa stems are comparatively fine and as the leaves usually retain a good color of about the same shade of green as the foliage of the timothy, the alfalfa appears to form a smaller proportion of the mixture than it actually does. The hay buyers generally will accept timothy containing considerably more than one-eighth of alfalfa, if the hay has been harvested in good condition, at about the same price that is paid for No. 1 timothy.

The second crop of hay harvested from fields having a mixture of clover or alfalfa with the timothy consists chiefly of clover or alfalfa and is graded as such. Most of the hay harvested from the second crop is fed on the farm where it is produced.

SUMMARY.

Timothy is extensively grown in the irrigated valleys of the Northwest, particularly in localities where hay is grown for market.

Timothy seed is almost invariably sown in mixtures with clover or alfalfa seed. The clover or alfalfa increases the yields and feeding value of the hay and helps to maintain the fertility of the soil. A meadow containing a mixture of clover or alfalfa will produce profitable crops for a longer period of years than if the timothy is grown alone. Alfalfa will usually continue to grow in the meadow for a longer time than clover.

The meadows are generally seeded in the spring, either alone or with a grain nurse crop. When a nurse crop is used about two-thirds as much grain should be sown as when no grass seed is sown with it. The nurse crop may be cut either for hay or grain. When utilized for hay the crop is removed from the field earlier, thus giving the timothy and clover or alfalfa seedlings a better chance for development than if the crop is harvested for grain.

Timothy may be irrigated by the same methods that are in use for other similar field crops. Timothy requires an ample supply of moisture near the surface of the soil. For this reason it should not be sown where the supply of water is likely to be deficient at any time.

Cultivating the soil by means of a disk or spring-tooth harrow is thought by most farmers to have a beneficial effect upon the meadow. The proper time to cultivate the meadows is in early spring before the plants have made much growth.

Stable manure will greatly increase the yields of hay, particularly on meadows which have been seeded for two years or more and where less hay is produced than when the meadows were new.

Most of the timothy meadows are pastured, usually in the fall. The meadows should not be pastured down too closely, nor should stock be allowed on the field when the soil is wet.

In some of the irrigated valleys in the Northwestern States, where the soil and climate are well adapted for the growth of timothy and where timothy production is an important industry, fields are frequently kept in meadow for a period of 10 or 12 years or longer. On most soils, however, the yields of hay become smaller because of the growth of weeds, etc., in about four to six years after the meadow has been seeded. When weeds have come into the field and the yields of hay have become small, the field should be plowed and other crops grown for two or three years or more before the meadow is reseeded.

Timothy growing in mixture with clover or alfalfa should be harvested soon after the timothy comes into bloom or even at a somewhat earlier date. Timothy hay growing alone produces the largest yields of the best quality of hay if it is cut at about the time of full bloom or within a few days afterwards.

Old meadows where weeds have come in, and which are in poor condition generally, produce only about $1\frac{1}{2}$ tons or less of hay per acre. Meadows in good condition and where alfalfa or clover is growing in combination with the timothy may produce yields of about 3 to $4\frac{1}{2}$ tons per acre from two cuttings.